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THE KNAPSACK AND PACK

AN HISTORICAL AND PHYSIOLOGICAL SURVEY WITH PARTICULAR
REFERENCE TO THE BRITISH SOLDIER

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PART II

(Continued from page 15, January issue)

EARLY TWENTIETH CENTURY

At the turn of the century, Zunz and Schumburg in Germany commenced their classic work on the energy expenditure of military load carriage, and the results were published in 1901 (29). The effect of a load on respiratory function was investigated; and it was shown that a load of 48 lb. decreased the vital capacity (respiratory efficiency) by 9 per cent., and one of 59 lb. by 11 per cent. It was demonstrated that the energy cost of marching increased almost proportionally to the mass moved; but with loads over 45 per cent. of the body weight, the metabolic cost rose disproportionately. Asymmetry of loading was shown to produce a triple increase of energy cost. Thus a rifle of 9 lb. slung over one shoulder was said to produce the same oxygen utilization as a weight of about 27 lb. in the pack. It was stressed that the carrying of heavy loads could lead to

venous engorgement of the kidney and lungs, to emphysema and dilatation of the heart; but such observations would, however, not be acceptable nowadays (32).

A notable landmark in the history of American Military Hygiene was the publication in 1901 of a textbook by Captain, later Colonel, Munson (30). In the chapter on Military Clothing and Equipment, we find a surprising wealth of information on the work done by Pettenkofer (31), Laveran (28), and other hygienists on the physiology of clothing. The section on the various aspects of load carriage by the soldier is done so well that it is doubtful if it could nowadays be improved upon, and it is not surprising that little has been added to the practical aspects of the problem. The contemporary American "Blanket Roll" and "Blanket Bag" came up for criticism, and a description of the British valise equipment of 1871 is given, as well as that of two new American patterns.

We are told that during the American Civil War of 1861-1865, the soldiers soon discarded their uncomfortable and heavy knapsacks, and carried the "Essentials" rolled in a blanket and slung over the shoulder. This was the origin of the regulation Blanket Roll, converted later into the Blanket Bag. According to Munson, neither the Roll nor the Bag was based on any sound principles. He added that "the Blanket Bag is the most vicious article in the equipment of the American soldier, . . . troops throw it away if hard pressed." It is noted that the British equipment was tried out by the American First Army Corps in 1896, with the following unfortunate conclusion: "(1) When packed the valise is convex at the back, and is therefore constantly wobbling; (2) without ball ammunition it is badly balanced; (3) practically the whole strain comes on the braces, which cut into the shoulder and check lung expansion; (4) the weight is so distributed that the heaviest portion, *i.e.*, the great-coat, is carried on the waist and drags on the loins; (5) equipment cannot be taken off and put on quickly without assistance; (6) all the drawbacks are emphasized on a small man." According to Munson, the equipment produced by General Merriam in America was far superior to the British valise equipment. It is of interest to note that mention was already made of the value of aluminium for use in the mess kit.

A description is given by Munson of the "Irritable Heart" or "Heart Strain" of the soldier, as described by Da Costa in 1871. It was clearly realized in America that some of the symptoms of "Pack Exhaustion" (pain in the chest, shortness of breath, weakness, dizziness, irregular pulse and collapse) were due to the "Irritable Heart"—a functional disorder—and not to valvular disease, heart failure, or to the heart "corn" of McLean. The present attitude to the effect of severe exertion on the heart and lungs is well reviewed by Abrahams (32).

An excellent monograph on military load carriage, from the viewpoint of the practical soldier, was published in 1902 by Commandant Lavis (33) of the French Army. This gave a detailed description, with diagrams, of the various forms of personal load carriage equipment used by the American and by the various European armies, and available at the turn of the century. The British equipment described is obviously the 1888 pattern. There is a critical discussion

of the total load, the comparative merit of high and low knapsacks, and the relative values of using the shoulders and hips in taking the weight. We are told that the knapsack was carried very high on the back by the French, Spanish and Italian armies; and that the weight was carried using both the shoulders and hips by the German, Austrian, English and Dutch soldiers. It was clearly realized by Lavissee that, in order to have stability with a high pack, supporting straps passing into the armpit were unavoidable, with consequent pressure on the blood-vessels and nerves of the arms. Lavissee himself was strongly in favour of a long, narrow, flat pack lying in the axis of the spine, supported by the hips (through the belt) and shoulders, and with the weight of the pouches balanced by the pack behind. It seems clear that Lavissee had predicted, by some fifty years, the principle in design of the British 1951 experimental web equipment.

With the Boer War of 1899-1902, tactics had to be improvised to deal with the fast-moving Boer commandos, and mobility of the soldier was now the order of the day. In the 1903 Report of His Majesty's Royal Commission on the War in South Africa, it was pointed out by Lord Elgin that Lord Kitchener had said of this campaign: "Our losses in ammunition, which itself proved a source of supply to the enemy, cannot be ascribed to want of care of the individual soldier, as much as the peculiar unsuitability of articles supplied to him, in which to carry his rounds." We are also told that in the opinion of Sir Charles Warren, "the knapsack or valise supplied was an absurdity." One commanding officer of an infantry battalion said that "the accoutrements were cumbersome, heavy and badly balanced." In imitation of the Boers, and in an attempt to prevent the loss of ammunition on the run, a bandolier (with 50 rounds), discarded in about 1680, was reintroduced. Brown leather at last replaced the buff "Slade-Wallace," and for the first time webbing began to make its appearance. The valise itself was completely discarded as being unsuitable; and the marching soldier normally carried only his arms and ammunition, water-bottle and haversack—a total of about 25 lb. Under these conditions a General's dream of an army of Light Infantry was actually realized. In 1903 there was an observation by Dr. Harvey Cushing (later the eminent brain surgeon) that rifle or pack drill could produce pain, weakness or numbness of the arms or hands, due to pressure on the nerves and blood-vessels passing under the clavicle (34). This condition of "Pack Palsy" was, however, already known to Pringle in 1752.

COMMITTEE OF 1906-1908: 1908 EQUIPMENT—PHYSIOLOGICAL TRIALS

Between 1906 and 1908 there were four meetings of the Committee on Physiological Effects of Food, Training and Clothing of the Soldier, the chairman of which was Surgeon General Sir Alfred Keogh. Most of the members were physiologists or medical men, and amongst them were illustrious names such as Sir Frederick Treves, the surgeon (who had played a valuable role in the Transvaal War), Professor J. S. Haldane, and Professor M. S. Pembrey. The secretary was a Captain Parker, R.A.M.C. The constitution of the Committee thus somewhat resembled that of the present M.P.R.C. of the War Office.

During the early days of the Committee, Major Burrowes, of the Royal Irish Fusiliers, had been collaborating with the Mills Web Equipment Company in producing the "Aldershot Design," later to be known as the "1908 Web Equipment." This pattern was placed before the Equipment Sub-Committee for examination. One fault of the previous equipments of 1871, 1882 and 1888 was that balance of the load between front and back was present only when the front pouches were filled; and when these were empty, the shoulders were pulled back and the belt was dragged upwards by the weight of the pack behind. According to the designers, the new principle allowed of a balance whether the pouches were empty or not; and this was brought about by a strap passing from below the ammunition pouches and diagonally across the back of the pack to its opposite and upper corner. A virtue of the new equipment was its good balance, which allowed the belt and jacket to be unbuckled during the march. However, we have noted that this particular virtue had already been claimed for the equipment of 1871. The load-carrying equipment was now for the first time made entirely of webbing, and was thus more pliable and adjustable than one of leather. The pack, whether large or small, was carried below the shoulder level, and lower on the back than the knapsack before 1871 or the valise of 1882-1888. The ammunition load of 150 rounds was distributed between the five pockets, which on each side constituted the new ammunition pouch. As in the case of the 1888 "Slade-Wallace" equipment, there were no constricting straps in the armpit. The whole equipment could be put on and removed in one piece.

Among the numerous trials done on this equipment there was one on the physiological aspects, carried out by Professor Pembrey and Captain Parker. The objective measurements used were sweat loss from the body and sweat retention of the garments during a seven-mile march. However, only two subjects were used at a time, and on occasion the Professor was included for good measure. The 1903 equipment, with belt buckled and tunic buttoned up, was compared with the new equipment with the belt unbuckled and shirt and tunic open, the load carried being approximately the same (both Drill and Marching Order were taken into consideration). As expected, with the belt and jacket undone, evidence was found of increased cooling, as shown by a decreased retention of sweat in the clothing. Since, however, the various experiments were done on days of different weather, and furthermore since the subjects were few in number, it is difficult to draw clear-cut conclusions as to the significance of the small differences found in sweat loss between the equipments.

In the Minutes of the Committee it is noted that: "With the old equipment it was necessary to keep the belt fastened, and in full Marching Order it had to be fastened tightly, otherwise the belt was dragged up by the weight of the great-coat behind. It is exceedingly common to see men during a route march in full Marching Order with the old equipment, jerking forward the body to relieve the pressure of the belt on the lower part of the chest. The bandolier with its ammunition is borne largely by the chest, and has to be raised with each breath. Due to its ingenious design, the new equipment is free of all these defects, and can be loosened or unclashed on the march. With the full complement of load,

both new or old equipment are excessive for the young recruit." The Committee referred to the perennial problem of a sweating back, and to the use of triangles, frames, and pads, all of which had been found useless. The fact was stressed that, for the load to be stable during "the double," it had to be closely applied to the back, with consequent poor ventilation. It was, however, pointed out (as had been done with most earlier equipments) that, with suitable adjustment of straps, some ventilation of the back could be obtained.

MILITARY HYGIENISTS, 1908-1914

Firth in his textbook published in 1908 said of the issue (1903) equipment: "It is light and simple; its most objectionable feature is the bandolier which, when loaded, presses heavily on the chest" (35). He spoke of a new equipment without a bandolier which allowed the belt to be unbuckled on the march, and of a trial carried out on a rucksack pattern. Commenting on the 1903 equipment, Melville said in 1912: "The bandolier was in use lately in our own army. . . . This method is the worst possible from the physiological point of view . . . it hampers every respiration and greatly impedes evaporation from the chest" (36). Strangely enough, the 1908 web equipment received no mention.

A later book, by Colonel Havard of the American Medical Corps, discussed briefly the problems of load carriage; and although published in 1914, delineated the 1903 pattern as the issue British equipment (37). Keefer in his textbook on Military Hygiene, published in 1914, still described the British 1888 equipment as the contemporary method of carrying loads (38). It is obvious that up to the First World War, knowledge of contemporary equipment, and the problems of load carriage, was not as extensive as it had been amongst the Military Hygienists towards the turn of the century. During the period 1912-1914, Brezina, Kolmer and Reichel published their work on load carriage by the soldier, and showed that with loads of more than 19 kilos (42 lb.) there was a disproportionate rise in energy cost, as measured by oxygen consumption (39, 40). It is of some interest to note the use of statistical methods by these early workers.

FIRST WORLD WAR, 1914-1918: THE LOAD CARRIED

With the onset of the 1914 war, the British soldier went into active service with the 1908 equipment, but owing to insufficient supply of web material, leather was used for all parts except pack and haversack. The total weight of equipment carried by the soldier in Marching Order had been reduced to 54 lb. in 1907, but rose to about 60 lb. by the beginning of the war. This latter figure was, in fact, simply a base line, which steadily rose as the war progressed. Because of the extra requirements in clothing, and the introduction of new offensive weapons and of defensive equipment (steel helmet and respirator of 1916), the weight increased to about 74 lb. in summer and to about 80 lb. in winter. And this was not all. The soaked great-coat contained up to 20 lb. of water, and water and mud on the rest of the clothing and equipment gave the possibility of a further 14 lb. Although transport was sometimes available, the

infantry soldier often carried up to 85 per cent. of his own weight, and was of course expected to fight at the end of a march. The soldier was now carrying on his person a load greater than he had ever borne at any time in history, and as a result marches of more than five to seven miles a day were never carried out in France with fully accoutred soldiers. At Cambrai, in November, 1917, the British infantry, exhausted by their great loads after an advance of about five miles, were unable to consolidate the positions opened for them by the first and historic mass attack by tanks. Lothian suggests that it is unlikely that either the renowned Greek Hoplite or the Roman Legionary carried on his person during the march more than about 55 lb. (41). It is true that porters in the East have for long carried loads up to 200 lb., but they do not fight, they walk at their own pace, and rest when they wish. In France, the infantry soldier had become far worse off than the pack animal, who is carefully tended and rarely allowed to carry more than about one-quarter of the body weight. Thus, figures generally accepted for such animals are: camel, cavalry horse or mule 25 per cent. and elephant 15 per cent. of the body weight.

During the First World War the German physician Rumpel showed in 1916 that long marches with heavy loads produced in a high percentage of soldiers changes in the urine (albumin and urinary casts) normally diagnosed as arising from kidney disease. A similar statement was made much earlier by Thurn in 1872 (42), and later by Collier in 1906 (43). The work of the Harvard Fatigue Laboratory during the Second World War confirmed the observations. It is, however, now known that the changes are transitory, and due in part to an exaggeration of the physiological decrease in blood supply of the kidney, with an increase in its water re-absorption, occurring during exercise and overheating of the body.

CATHCART SCHOOL AND CHEYNE, 1919-1926: ENERGY EXPENDITURE STUDIES

After the end of the war the physiologists Cathcart and Orr (44) published a report on the "Energy Requirement of the Infantry Recruit in Training." They pointed out that continental armies carried loads high up on the back, and this necessitated a forward stoop associated with a constant hitching up of the load. In order to assess the most suitable position on the back for a load, they carried out a series of preliminary experiments on energy expenditure, using a constant total weight, but with differences in symmetry of loading and of position of the pack on the back. Their results suggested that a considerable latitude could be allowed in the way a given weight was carried, and this did not appear to bear out the earlier findings of Zunz and Schumburg on the effect of asymmetric loading. It was also stated by Cathcart and Orr that "the high position for a pack does undoubtedly reduce the expenditure of energy, and we may assume that the load is carried more easily." The former statement, however, does not appear to be borne out by the data presented. Some preliminary experiments were also carried out on the physiological maximum load, and this appeared to be in the neighbourhood of 45 per cent. of the body weight.

After the 1914-1918 war, the "Army Hygiene Advisory Committee" continued its activities, and Professor Cathcart as a member maintained active interest in the problem of load carriage. During the war, many complaints had accumulated on the poor balance of the 1914 equipment. This necessitated leaning forwards with a tight belt to prevent the pack slipping down, with a consequent drag on the belt. The age-old criticism of the shoulders being pulled back was brought up again. In order to overcome these perennial defects, and to decrease the wobble of the pack, Cathcart and Lothian (on the suggestion of Major Johnston Stirling, R.A.M.C.) introduced in 1923 two modifications of the 1914 equipment, viz. (1) attachment of the pack to the shoulder straps, near the midline of the pack and about one-third from its top border (as in a rucksack), and (2) supporting straps passing from just above the pouches in front, to the lower angles of the pack below. It will be noted that similar supporting straps were already present in the 1871 and 1882 equipments (Fig. 3). The first modification had already been suggested forty years previously by the 1879-1881 Committee.

Using such modifications, laboratory experiments were carried out by Cathcart and Lothian, and the results showed an apparent saving of 17 per cent. in energy cost during marching (45). With judicious adjustment of straps, the pack fell away a little from the body, giving some ventilation of the back. It was also asserted that "whether an equipment is good or bad can be judged by (a) its appearance and movement during work, (b) the feelings of the man carrying the load, and (c) the energy expenditure in carrying the load. As regards (a) and (b) there may be difference of opinion, but the estimation of the energy expenditure should prove an unfailing guide as to the best form of equipment, and the best distribution of the load" (45). This last statement will be taken up again later. It is to be noted that nothing came of the results of the experiments, or the suggestions put forward by the physiologists.

During 1923 appeared the classic work of Cathcart, Richardson and Campbell on the relationship of load carried by the soldier to the energy consumption (46). They showed that the maximum load for maintenance of efficiency and health under laboratory conditions was about 40 per cent. of the nude body weight, and for Service conditions accepted the traditional one-third body weight. Although the work was done with great care and accuracy, only two experimental subjects were used (Richardson and Campbell), and the experiments were done solely under laboratory conditions. It is obvious that under field conditions of prolonged activity, bad weather and terrain, with poor sleep, little rest and insufficient food, the figure may be appreciably less than one-third of the body weight. It is furthermore an acceptable truism that the optimum economic load to be carried by the fighting soldier is no load at all. However, the figure of one-third has become more or less generally accepted as the maximum load compatible with efficiency; and as such it corresponds to that laid down independently by military writers such as Von Plonnies and Thurnwald during the end of the nineteenth century, to the results of the physiological researches of Zunz and Schumburg, and later to those of Brezina, Kolmer and Reichel (39, 40).

In 1924 there appeared a paper by Bedale (47) on the load carried by women in industry. Of the eight different methods of carrying a load that were examined, yoke carriage of the milkmaid was found to be the most efficient, from the viewpoint of energy expenditure, with loads of 20 to 50 lb. It was also shown that load carriage on the back by a rucksack was often as efficient as carrying the load on the head. The point is made here, because it is still often assumed that the latter is a very efficient method; but this is probably true only after a very prolonged period of training. Evidence from the data in the paper suggested that for most forms of load carriage there is a proportional rise in energy expenditure for loads over 40 lb. However, the data were derived from only one female subject.

Another report on load carriage by the soldier was published in 1926 by Captain Cheyne, R.A.M.C. (48), who had followed up the earlier suggestion of Cathcart and Orr as to the value of a high position for loads on the back. He agreed that a high position produces a slight stoop forward, but since most of the respiratory movement in a man takes place in the lower part of the chest, this high position would *per se* not impair breathing efficiency. Cheyne believed that the fault of the 1908 pack was due to its being carried below the shoulder level, to the tendency of the shoulder strap to slip down the shoulders, and hence for the pack to lose its stability. As with Cathcart and Lothian, he suggested that the points of attachment to the upper part of the pack be central and below the upper border. This would prevent slipping of the shoulder straps, bring these closer to the root of the neck, and allow a high position for the pack on the back. In order to produce stability in this position, supporting straps were passed from just above the ammunition pouches in front to the belt at the back. The attachment was not made to the lower angle of the pack (as done by Cathcart and Lothian), because with the high position of the load the supporting straps would have to pass high up in the armpit. Cheyne believed that with a high position and small pack, the armpit tends to be compressed by the supporting straps. Using his modifications, he carried out experiments on 15 men marching in a laboratory, and claimed a saving of about 13 per cent. in energy expenditure. Together with this there was greater comfort in marching, and an increased cooling of the back.

BRAITHEWAITE COMMITTEE, 1933: 1937 EQUIPMENT

Little active research was done on the problem of load and equipment during the peace years of 1926-1934, but Atzler published his monograph on the Physiology of Work in 1927 (49), and the results of Crowden's investigation on load transport in the brick industry appeared in 1928 (50). In 1935 the Braithewaite Committee on the Dress and Equipment of the Infantry Soldier was set up, with Major-General Henderson, Director of Hygiene, as medical representative. During the meetings it was pointed out that "the experience of the Great War had shown notably that the infantry soldier had been definitely overloaded, and few if any instances had come to light of his running out of ammunition." It was stated that the average peace-time weight of the soldier

could be taken as 135 lb., and that, if practicable, not more than one-third of the body weight be carried as a load. Fifty rounds were suggested as suitable for Marching Order, and 100 for Battle Order. Recommendations were put forward for the pack to be carried high on the shoulders, with no equipment below the waist. It was noted that "a new improved design of web equipment was under way, and that this would allow of greater comfort, and permit the buckle to be unfastened on the march." This perennial claim had been put forward for all equipments from 1865 onwards, only to be retracted before the appearance of a new pattern.

In 1937 the new equipment produced by the Mills Company came into official use. It had the advantage of being lighter than the 1908, and adapted to suit different arms. There was no large pack for Battle Order, but instead a roomy haversack as it was anticipated that the large pack (1908 pattern) would normally be carried in regimental transport.

SECOND WORLD WAR, 1939-1945: PHYSIOLOGICAL TRIALS

During the Second World War the 1937 web equipment was used generally in all theatres of war. Some time in 1942 a completely new design in personal load carriage equipment was being put forward by Colonel Rivers-Macpherson, Chief Ordnance Officer of the Field Stores, Aldershot. He stated that "web equipment was the high spot of its day, when the tempo of attack was infinitely slower than that of today, but one can say without hesitation that basically web equipment was no advance on what had been worn 100 years ago." All forms of web equipment having a waist belt came up for criticism, in part for the medical consideration that they "press on the duodenum." In point of fact, this part of the small bowel is well sheltered by the liver, and in part by the stomach itself. It was also stated that "the Trapezius weight-carrying muscle has been designed by nature, to carry heavy loads." Apart from teleological implications, the Trapezius acts mainly in keeping the shoulder girdle in position; and during the carriage of heavy loads by professional porters, the weight is mainly supported by the pelvis, and by the back with its ligaments and extensor muscles. As an improvement on the issue equipment, Rivers-Macpherson put forward the battle jerkin (51), based on the poacher's jacket. Small scale trials were carried out on this pattern, and as a result it was suggested that it replace the 1937 equipment.

In August, 1942, a physiological trial was carried out on the battle jerkin and 1937 equipment by the Hygiene department of the Royal Army Medical College. Six soldiers were used, carrying 45 per cent. of the body weight, in marches of four hours' duration. The following measurements were taken: (1) Energy expenditure, (2) vital capacity, (3) respiratory rate, (4) pulse rate, (5) recovery period. Little difference was found between the equipments in any of these measurements. During the period of trial the external conditions varied from 45° F. to 57° F. (relative humidity not given); and since the equipments were not randomized between the various days, it would have been difficult to draw valid conclusions even if appreciable difference had been found.

In spite of this, it was concluded that certain results were in favour of the battle jerkin. Other trials suggested that the stiffened waterproofed cotton duck of the jerkin made a man hotter than did the 1937 equipment, but this assertion was never clearly proved. In order to fit all men, three sizes of jerkin were necessary, and this brought up problems of replacement. Later in 1944 a skeleton type of battle jerkin was produced. But apart from the battle jerkin being used in localized theatres of war, the principle was dropped until taken up again after the war by the Canadian Army and by the Ministry of Supply.

During the war the old problem of the maximum load to be carried by the soldier was reviewed again, and in 1942 a field trial was carried out by the War Office Department of Hygiene (52). As in the trials of the 1879-1881 Committee, rifle fire was used as an objective test of the fighting efficiency of the soldier, but with the difference that the accuracy of the fire was now measured. Other objective tests used in the trial were the time taken to traverse an assault course and the time of recovery of the pulse and respiration. The weights carried by the men varied from 23 to 43 per cent. of the body weight. The external conditions varied from 59° F. to 70° F. with relative humidities of 52 to 95 per cent. It is stated in the report that "it would seem, therefore, that at 40 per cent. of the body weight, the soldier reaches the absolute maximum load to be carried into action." However, although this conclusion is suggested by superficial examination of the tables, a closer scrutiny reveals that the learning factor, as well as the varying weather conditions, played a part in the results. Since the experiment was not designed (as admitted in the conclusions) to eliminate such factors, the conclusions are hardly warranted.

As a result of the Lethbridge Mission to the Far East towards the end of the war, decisions were taken to modify the 1937 equipment for use in jungle warfare. Basically, the new equipment so produced—the 1944 web equipment—is the same as the 1937, but with the web thinner, lighter and more pliable, and with wider shoulder straps. An aluminium water-bottle was now introduced (as suggested by Munson in 1901). Modifications were developed to overcome the various criticisms of the 1937 equipment raised during the war, both in trials and during active field service. It was claimed that the new method of support allowed the basic pouches to be stabilized without a counter-balance on the back. After a number of trials carried out during the period 1946-1948 it was concluded, however, that the new design, even with modification, was inferior to the 1937 pattern; and as in the past, the shoulders were pulled back and the belt dragged up over the abdomen. An obvious disadvantage in both 1937 and 1944 patterns is the presence of the supporting strap passing high in the armpit when a small pack is carried high on the back. In addition, the 1944 equipment shows a return to the use of a chest strap (albeit loose), so condemned by Professor Parkes and the Committee of 1865-1868 (Fig. 3).

A valuable paper on the physiological background of load carriage by man pack was produced in 1944 by the Middle East W.T.C. Mountain Wing (53). This analysed both the static and dynamic forces concerned in load carriage, and pointed out that web equipment was unsuitable for loads over 20 lb., owing

to the marked tension on the shoulder straps. A paper on very similar lines and conclusions was published in 1950 by Colonel Kapur of the Indian Army (54). In 1947, the Operational Research Section (India) published a report by Newsome and Singh on the relationship between the weight of the soldier, the load carried by man pack, the distance marched, efficiency and fatigue (55). The Havard Pack Test (56) was used as an index of general "efficiency" of the soldier, and "fatigue" derived from scores obtained before and after exertion. However, it is not clear that either of such measurements is valid (57, 58). The experimental subjects carried randomized loads during marches of five and seven miles. Since, however, the trial was not designed to eliminate either learning factors, acclimatization or varying weather, it was not possible to draw clear-cut conclusions as to the effect on the man of either the weight of the load or the distance marched.

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End of Part II.

(To be continued)

THE PRINCIPLES OF PREVENTION OF COLD INJURIES

NOTES ON THE PROBLEM AS ENCOUNTERED, AND THE METHODS USED, IN KOREA

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[This paper has been written without reference to standard works or recent publications, only those published locally being available to the writer at the time. An attempt is made, however, to summarize, discuss and correlate current trends of thought on this subject, and to interpret these in the light of experience gained in Korea.]

DEFINITION

Cold injuries may be defined as local lesions, usually of the extremities, directly or indirectly due to cold which would not occur under similar circumstances in temperate climates; this paper will be largely concerned with cold injuries of the feet.

Such lesions are known by a variety of names, e.g., immersion foot, shelter foot, trench foot, and frostbite; and at times the differential diagnosis between the various types may be quite difficult. A true case of frostbite is not difficult to distinguish from a thorough-going trench foot, which in turn can easily be distinguished from a simple case of hyperidrotic maceration. There are, however, innumerable intermediate grades between these three types of case,